EXTERNAL FEATURES OF YOUNG CRYPTOCHITON.

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The genus *Cryptochiton* includes the most highly modified individuals in the order of the Polyplacophora so far at least as excessive growth of the mantle and the consequent diminution in size of the tegmentum is concerned. In the adult no trace of the tegmentum is visible, the articulamentum alone remaining, being completely hidden within the mantle. While it is held by many that this represents the last stage of a process by which the mantle gradually encroached upon and finally destroyed the tegmentum, Reincke[1] considers it to be a primitive condition from which the remainder of the Chitons have been modified. The following observations on the young of *Cryptochiton stelleri*, are of interest in this connection.

In many places along the coast of California this species is of frequent occurrence. In and about Monterey Bay they are quite common out beyond tide marks, where the water is from six to twelve feet in depth. Sometimes they may be seen in the dark hollows and crevices, slowly moving about in search of food, which consists mainly if not entirely, of plants.

On July 14, 1896, two young specimens were found on the underside of stones at the extreme low tide mark. They were placed in an aquarium at the Hopkins Seaside Laboratory and were kept for several weeks but they were always sluggish, remaining quiet for days together in the dark corners or under stones. They did not exhibit any peculiarities worthy of note.

They were oval in outline, the broader end being anterior, and were of the same size, having a length of 27 mm. and greatest width of 15 mm.

Adult *Cryptochiton* are of a dark red color, sometimes obscurely blotched with white. The young were unlike in coloration, one having a light orange-yellow color shading to orange on the mid-dorsal line; the other was of a light green also darker in the region of the shell. In both the tint was lighter on the ventral surface. The bunches of calcareous spines that cover the dorsal surface contain

[1] Zeit. für wiss. Zool. Bd. XVIII, 1868.

some of a crimson color and these modify to a considerable extent the general color.

In adults there are from 71–80 gills. In the young there are 56 arranged as in the adult. Anteriorly they shade off into minute papillæ not visible to the naked eye.

Full grown *Cryptochiton* are covered on the dorsal surface with groups or tufts of calcareous spines so closely crowded together that the mantle is almost or entirely concealed. In the young the groups are smaller and much more scattered (Plate VIII, fig. 1); in addition are multitudes of small crimson spines on both the ventral and dorsal aspects of the mantle. Reincke, and especially Blumrich[2] have worked out the development of the spine in several species of *Chiton*. It forms above and outside the epithelial cell, from which it develops, and as the spine increases in length, its base with its underlying cell becomes pushed into the mantle and a hollow is thus produced. Many spines forming these hollows occur in such positions as to produce a circular groove and the small area of epithelial cells surrounded by this groove becomes a papilla. In young *Cryptochiton* the entire mantle surface is thrown into these papillæ which become clearly outlined by the spines which form in the channel about them (Plate VIII, fig. 4). These small spines not collected into tufts are elliptical in cross section and the calcareous portion imbedded in an organic basis is made up of four pieces. The arrangement of these pieces is similar to that produced by longitudinally splitting into fourths a cone of small base and high altitude.

In the tufts of larger spines there are always to be seen a number of short bright crimson ones from which others generally colorless seem to radiate. These are not centrally located, but excentrically on the side of the tuft next to the median line. A section through either a large or small group shows a comparatively deep depression in the mantle from which these crimson spines project. In the epithelium of the depression, on the side next to the mid-line, new spines form in considerable numbers. As others develop the preceding ones are pushed toward the outside or away from the median line (Plate VIII, fig. 5). They are at first colorless but when about half formed show a crimson tint, which gradually disappears by the time they are pushed out of the cavity. These spines

[2] Zeit. für wiss. Zool. Bd. LII, 1891.

are probably homologous to the small ones of the general mantle surface but, unlike them, consist of but one calcareous shaft imbedded in chitinous matrix which remains after decalcification.

Pilsbry[3] has placed the *Cryptochiton* as an offshoot from the Acanthochitoid stock. In the Acanthochitidæ there are always sutural tufts or groups of spines corresponding in number and position to the valves of the shell. In this relation it is interesting to note that we have a similar arrangement in the young *C. stelleri*. On each side of the mid-line are tufts opposite each valve that are larger than any others in this region, and show a distinct regularity of position (Plate VIII,fig. 3). There are multitudes of other groups, but they are scattered irregularly over the mantle and do not in any way correspond to the position of the valves.

Along the median dorsal line, corresponding to the posterior portion of each valve, is a series of eight openings. They are about 0.5 mm. in diameter and through them the shell is plainly visible. Carefully dissecting out the valves, which are pure white and of the same shape as those of older specimens, a well defined tegmentum is visible (Plate VIII, fig. 2). In most cases it exhibits growth lines and obscure ribbing of no definite pattern. The color is generally white, sometimes slightly greenish, and is generally tinted posteriorly and in some cases anteriorly with light red pigment. No tegmental sense organs (æsthetes) were seen.

On the valves of specimens almost fully grown, in a position corresponding to the tegmentum on young shells, one may see a small brown spot of about 0.5 mm. diameter which Middendorff[4] named the *nabel* or umbo. This investigator figures a section where a plug of some brown organic material something like chitin projects from the umbo about half way through the mantle. This is covered by columnar or pavement epithelium and while it is spoken of as the "navel" by Middendorff, he states that he is unable to explain its significance. It beyond doubt represents the opening through the mantle as found in young specimens and consists of the degenerate tegmentum over which the mantle has closed and partially fused.

Thus it is seen that no Chiton so far as known exhibits throughout life a condition where the shell is wholly concealed within the mantle. By its development we are justified in saying that *Crypto-*

[3] Manual of Conchology. Vol. XV, Part 57.
[4] Mem. de l'Acad. St. Petersbourg. Tome VI, 1849.

chiton is not a primitive Chiton, but represents the last of a series which has undergone successive modification, by which the tegmentum, orginally the same size as the articulamentum, has gradually disappeared. Paleontological evidence also supports such a conclusion.

EXPLANATION OF PLATE VIII.

Fig. 1. Anterior portion of the mantle showing the tegmentum of the first and second valves. This shows the accurate arrangement of the spines in this region. × 12.

Fig. 2. First and second valves showing the size of the tegmentum. × 6.

Fig. 3. Young *Cryptochiton* showing the tegmenta and sutural tufts. × 3.

Fig. 4. A group of spines seen from above, with the characteristic arrangement of the small mantle spines (represented by dots) about the papillæ.

Fig. 5. A cross section through a tuft (as in fig. 4) showing the development of the spines.